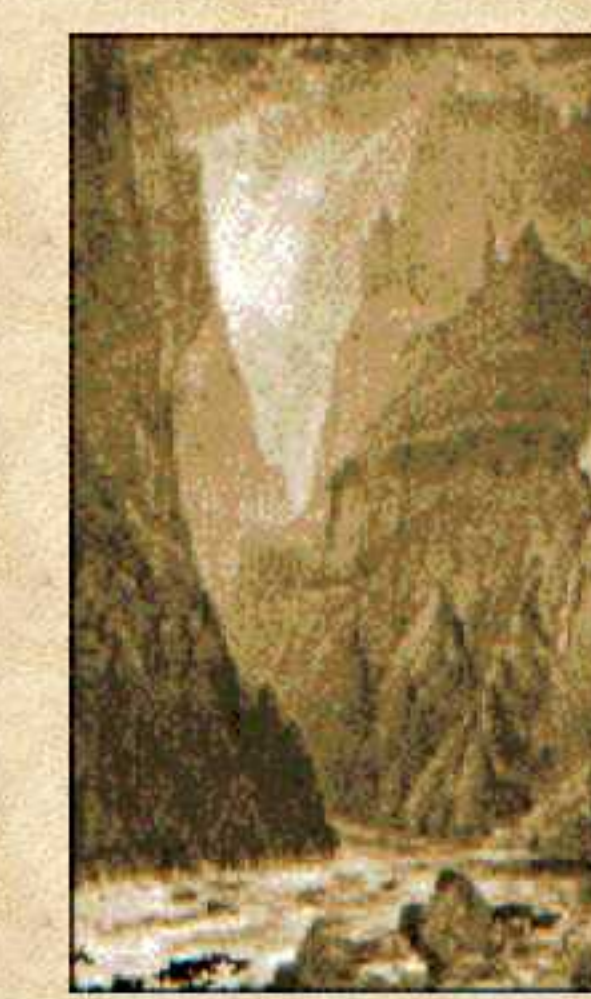
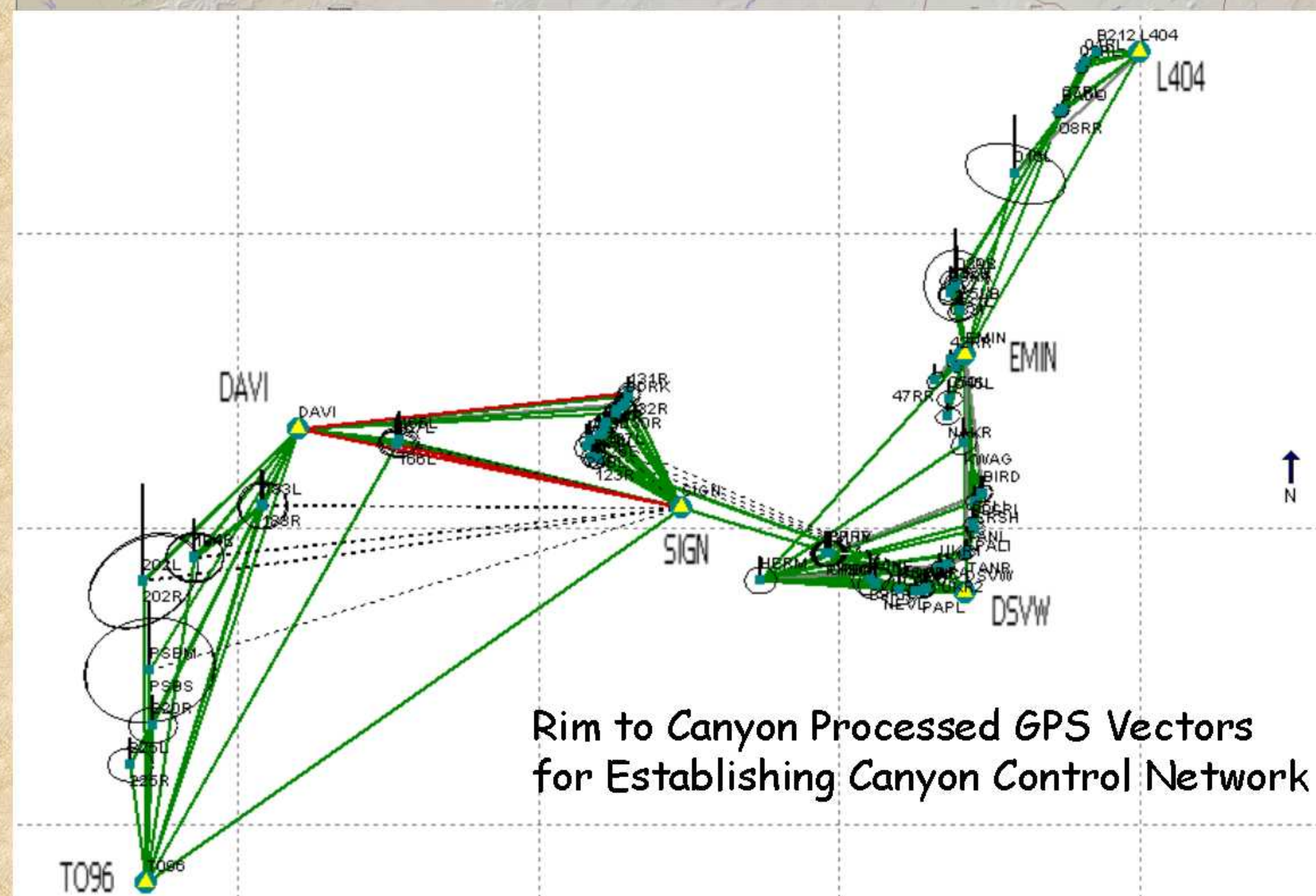
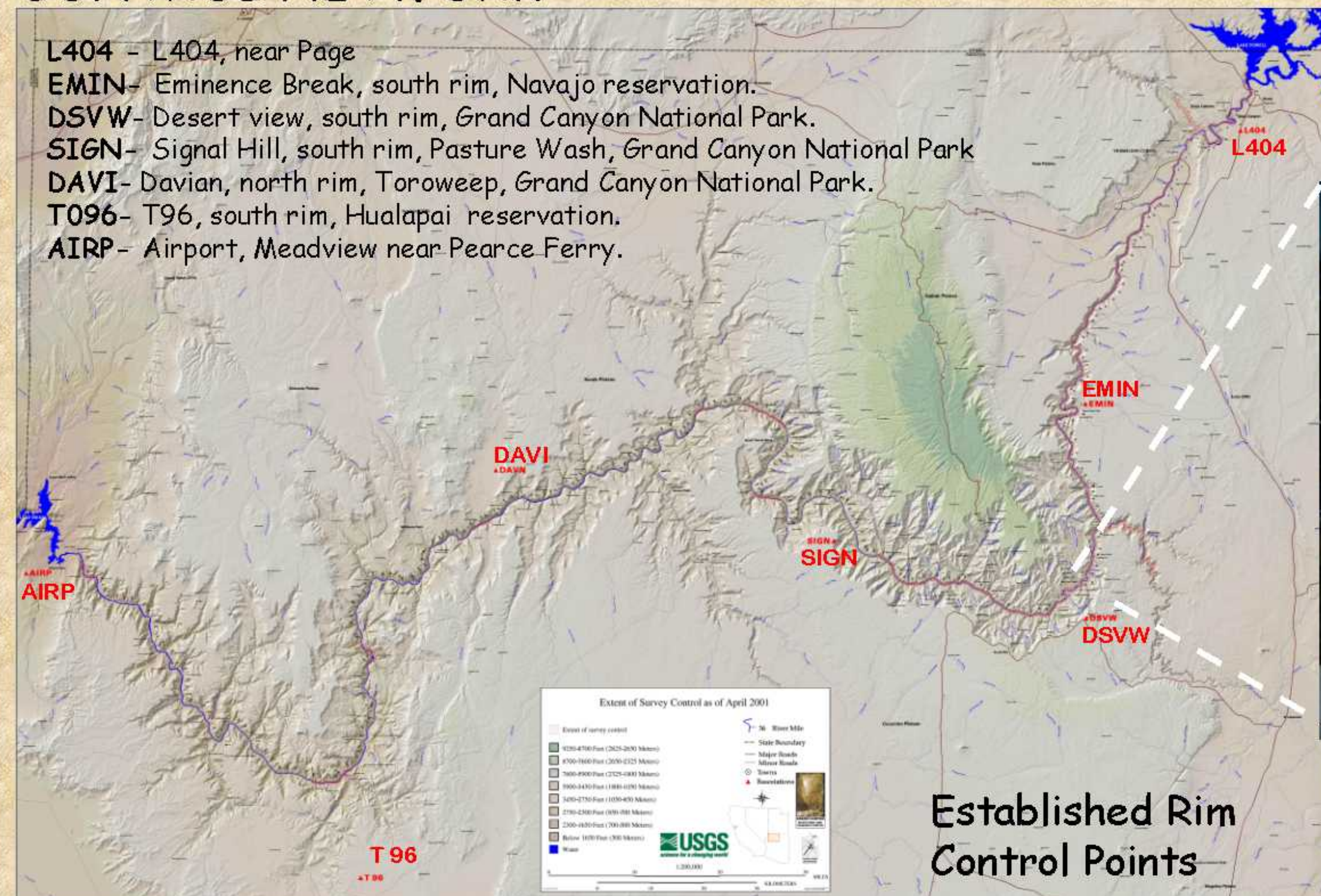


# Survey Control Operations in Grand Canyon



## CONTROL NETWORK



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 Mark Gonzales, Survey Coordinator, GCMRC  
 Keith Kohl, Survey Technician, GCMRC



DSVW  
Desert View  
Rim Control Monument



GCMRC Brass Disk on a  
concrete pedestal

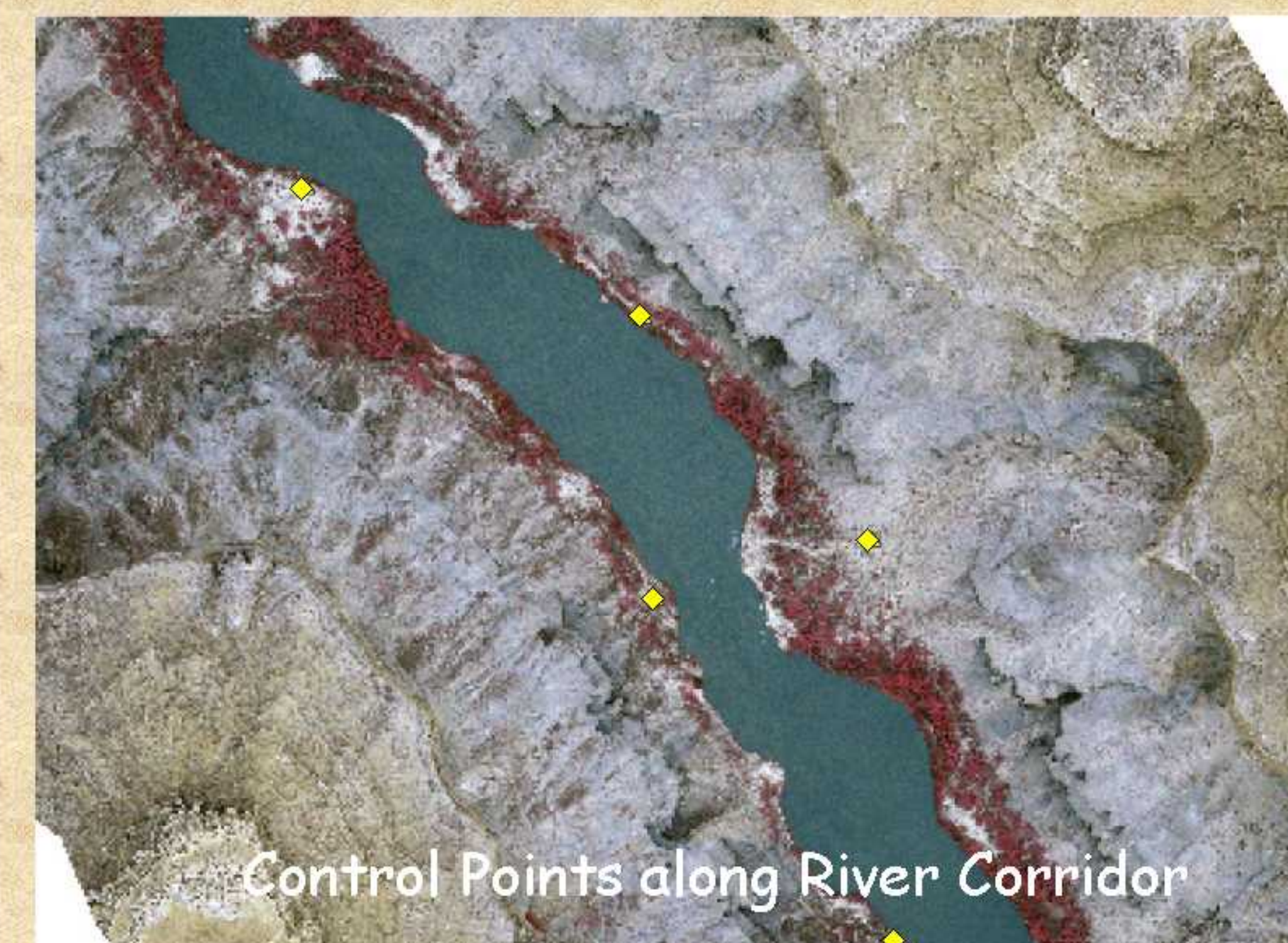


River Corridor GPS  
Control Point



Conventional Traverse Point

The established control on the rim transfers to river corridor control points through simultaneous GPS occupations. Subsequently, positional accuracy from river corridor control points is transferred to all mapping along the river corridor through conventional surveying techniques.



Control Points along River Corridor

## SURVEY CONTROL

Survey control in the Colorado River ecosystem is required to meet the demands of any spatial measurements for scientific monitoring and research. Survey control also supports the spatial positioning of hydrographic and bathymetric channel mapping as well as ground control for aerial mapping or remote sensing applications.

In order to meet GCMRC's positioning needs, the existing control reference system must be continually enhanced to provide the high accuracy required for use with GPS and conventional measurements. In association with National Geodetic Survey, GCMRC has established a GPS control network of monumented points having three-dimensional positions.

## CONTROL POINTS



Rim Control Point in Glen Canyon  
and close-up of benchmark.



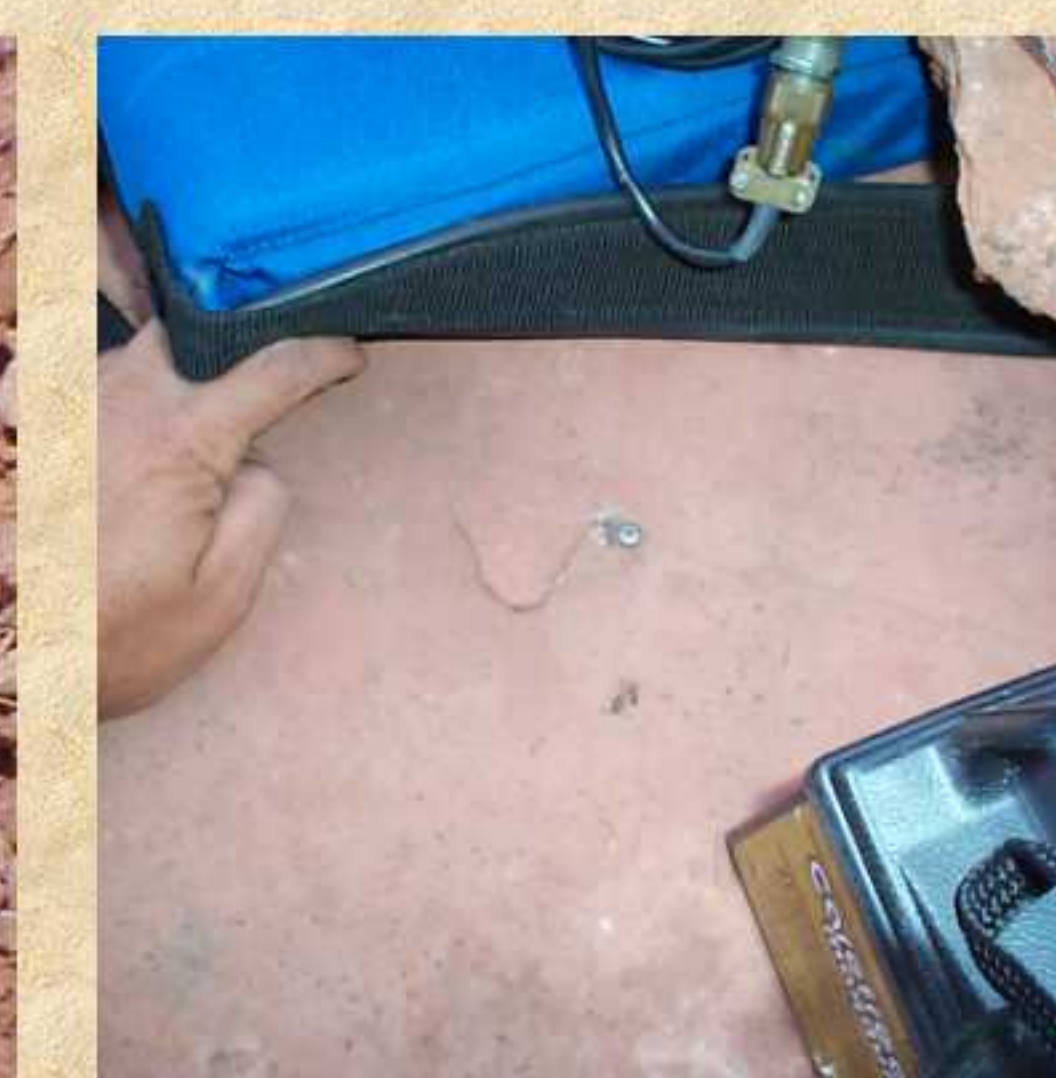
Desert View Rim Control  
Point established by GCMRC



Benchmark along river  
corridor.



Benchmark established by GCMRC contractor,  
Banner Inc., along river corridor.



Screw in lead control point  
along river corridor.



Scribed "X" in rock control  
point along river corridor.

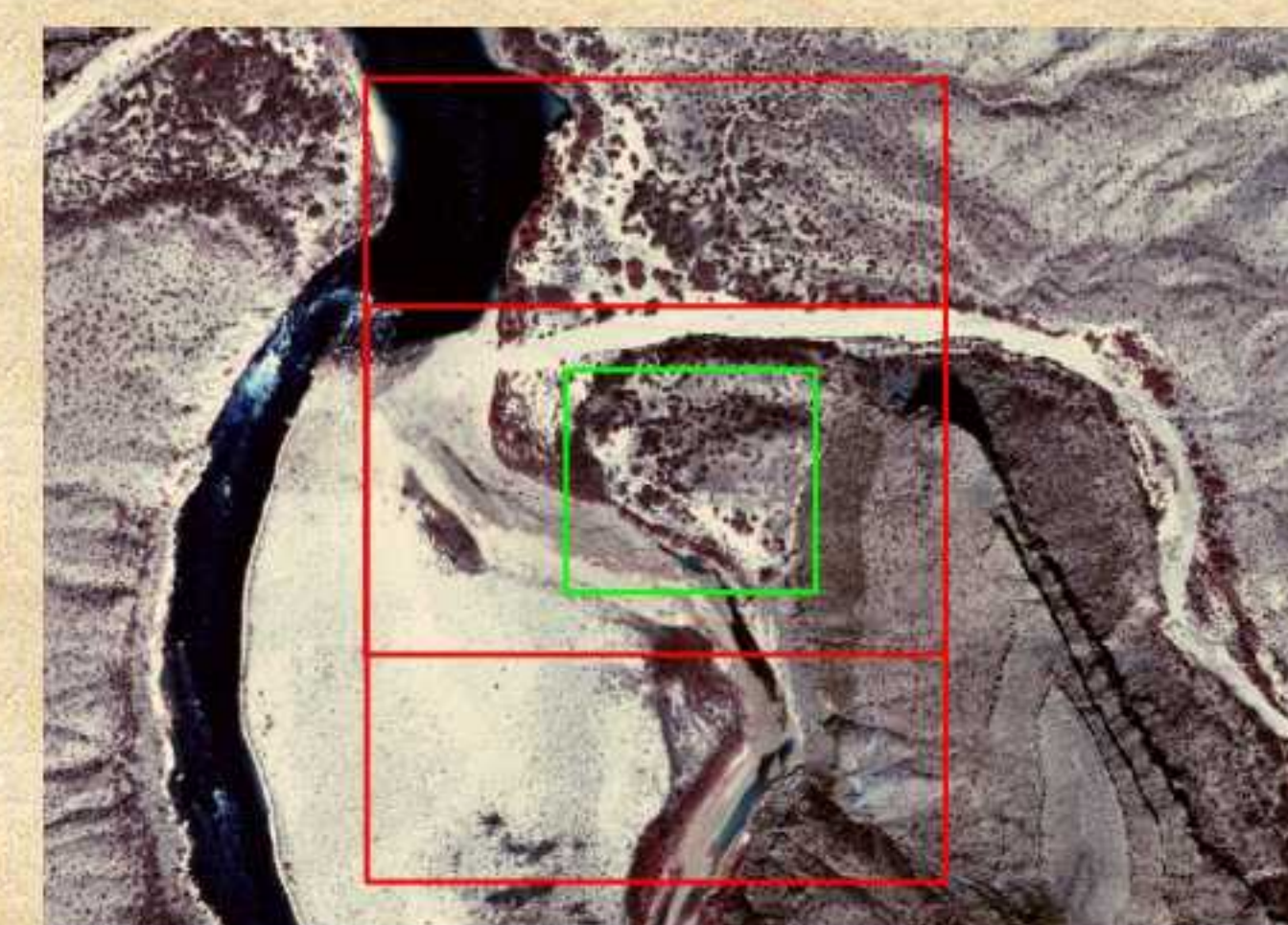
The GCMRC survey department tries to minimize all potential impacts to the Grand Canyon river environment. Whenever possible, existing control/survey monumentation is utilized. This includes bolts, X-cuts, nails, and survey monuments. However, in some cases it is necessary to set new points. These points are very carefully selected to be unnoticeable by the average person. When absolutely necessary, a small X is scribed on a rock. Extreme care is always taken to avoid any survey operations on or near cultural sites unless that site is specifically being mapped.

## TOPOGRAPHIC AND HYDROGRAPHIC MAPPING



The control network is the positional infrastructure for all surveying, mapping, and remote sensing operations in the Grand Canyon implemented by GCMRC. Mapping projects require up to 2-centimeter local accuracy and 5-centimeter accuracy overall.

## PHOTOGRAMMETRY TARGETS AS GROUND CONTROL



Photogrammetry targets are laid on known control points for stereo rectification of aerial photography as well as other remote sensing applications. These panels provide a much less intrusive operation on a site than physically doing a ground survey.



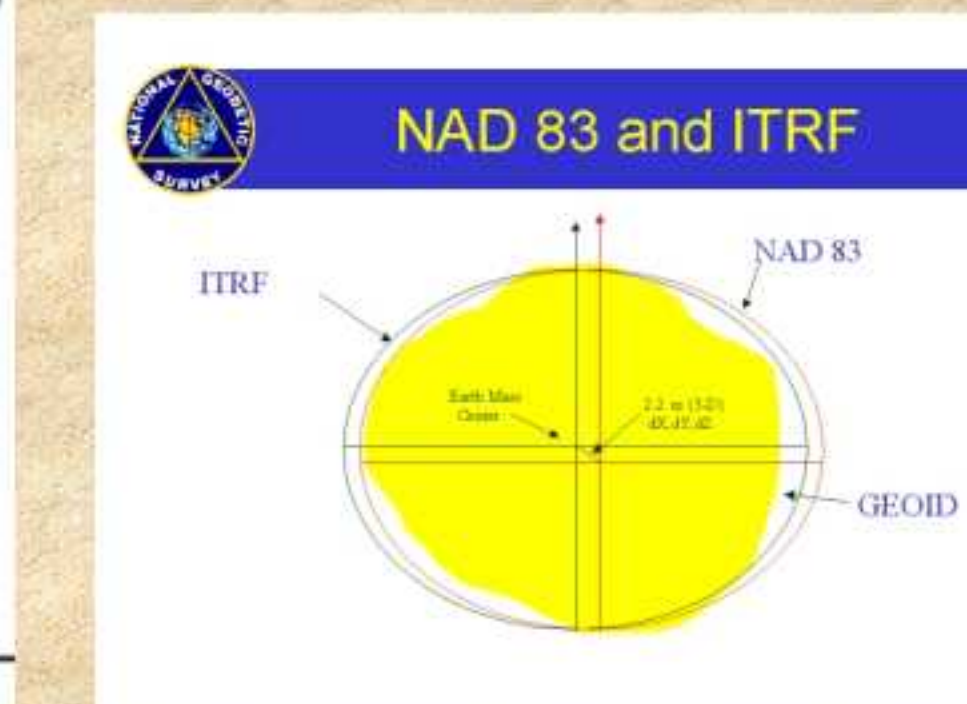
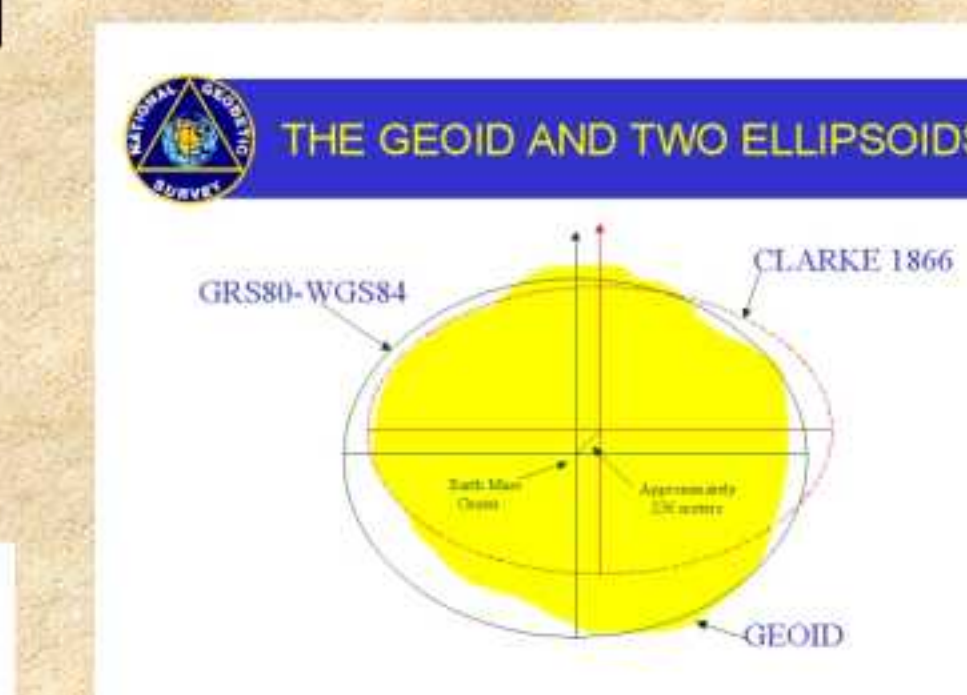
## INTRODUCTION

The Survey department's mission is to provide survey support for spatial measurement and referencing of scientific data collected in the Colorado River ecosystem by GCMRC programs. The Survey department establishes and maintains accurate geographic control in the Canyon that is essential for accurate geo-referencing of remotely sensed data and spatial analysis of resource data using modern image processing and GIS technologies. These technologies are critical to the integration and analysis of the diverse scientific data that have been collected in the Canyon over the past 15 years. Products requiring accurate positional control include precise sample location coordinates, topographic maps, river channel maps and cross sections, digital elevation models, and digital terrain models. This information provides the basis for spatial analysis of data within the ecosystem using GIS software that in turn provides area and volumetric change detection capabilities of resources.

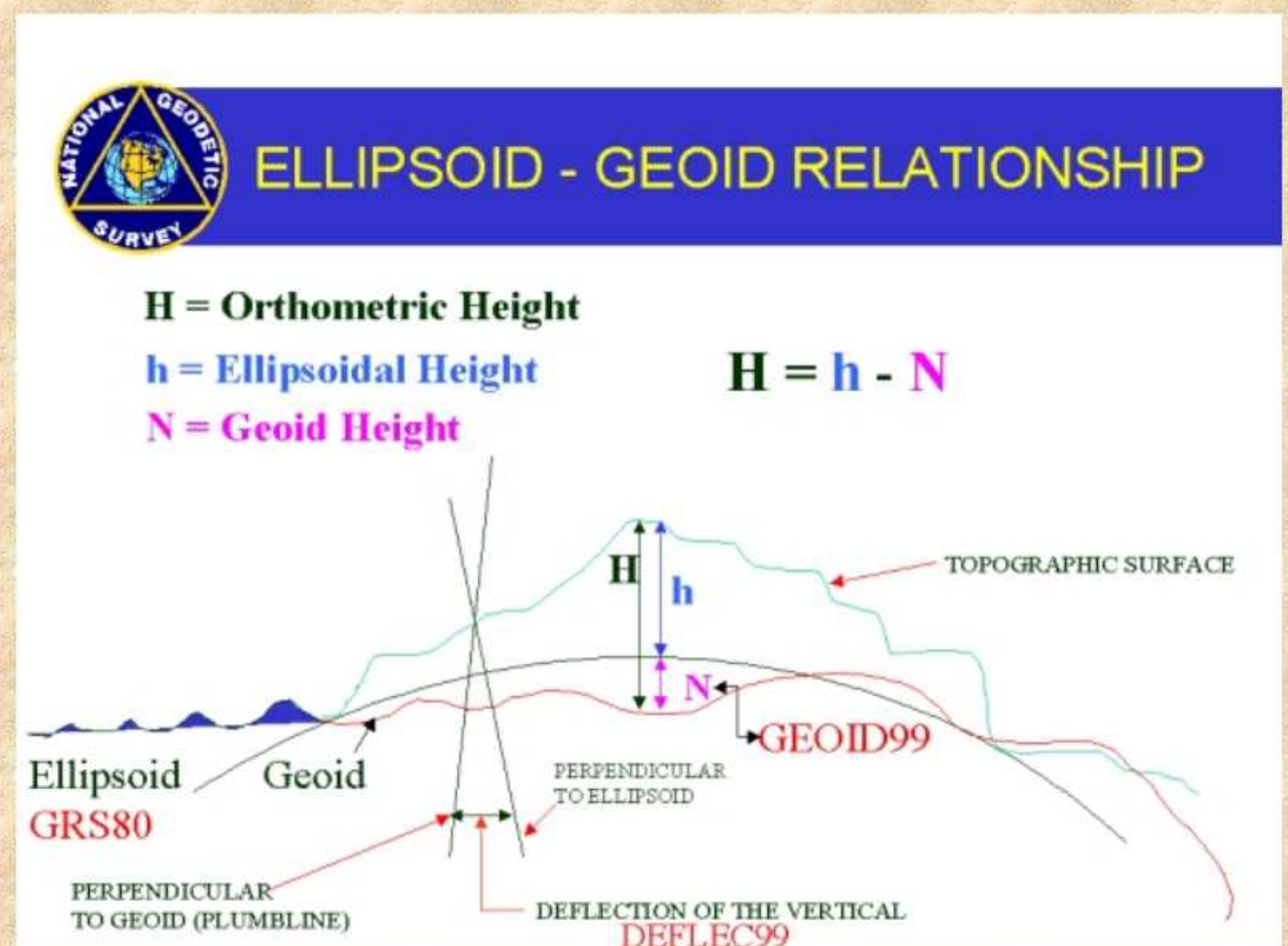
The control network was initiated in 1990 when it became necessary to establish topographic control for research sites as well as all other research related mapping in the Grand Canyon. The development of sound topographic and mapping control required good survey control to build these spatial data sets. However, as a result of extremely difficult logistics and access to the river corridor, a reliable geodetic control network had never been established.

Banner & Assoc. set ground control points and established coordinates to support BOR remote sensing efforts. In 1991 Joseph Mihalko (NPS surveyor) occupied the Banner ground control points and found that the control points did not meet their claimed accuracy and precision. As a result, GCMRC established a survey department to correct all previously established survey control as well as meeting all the research needs of the future.

The Survey department uses a variety of technology to assist in accomplishing its mission in a timely manner utilizing Global Positioning Systems and Conventional Survey Technology.

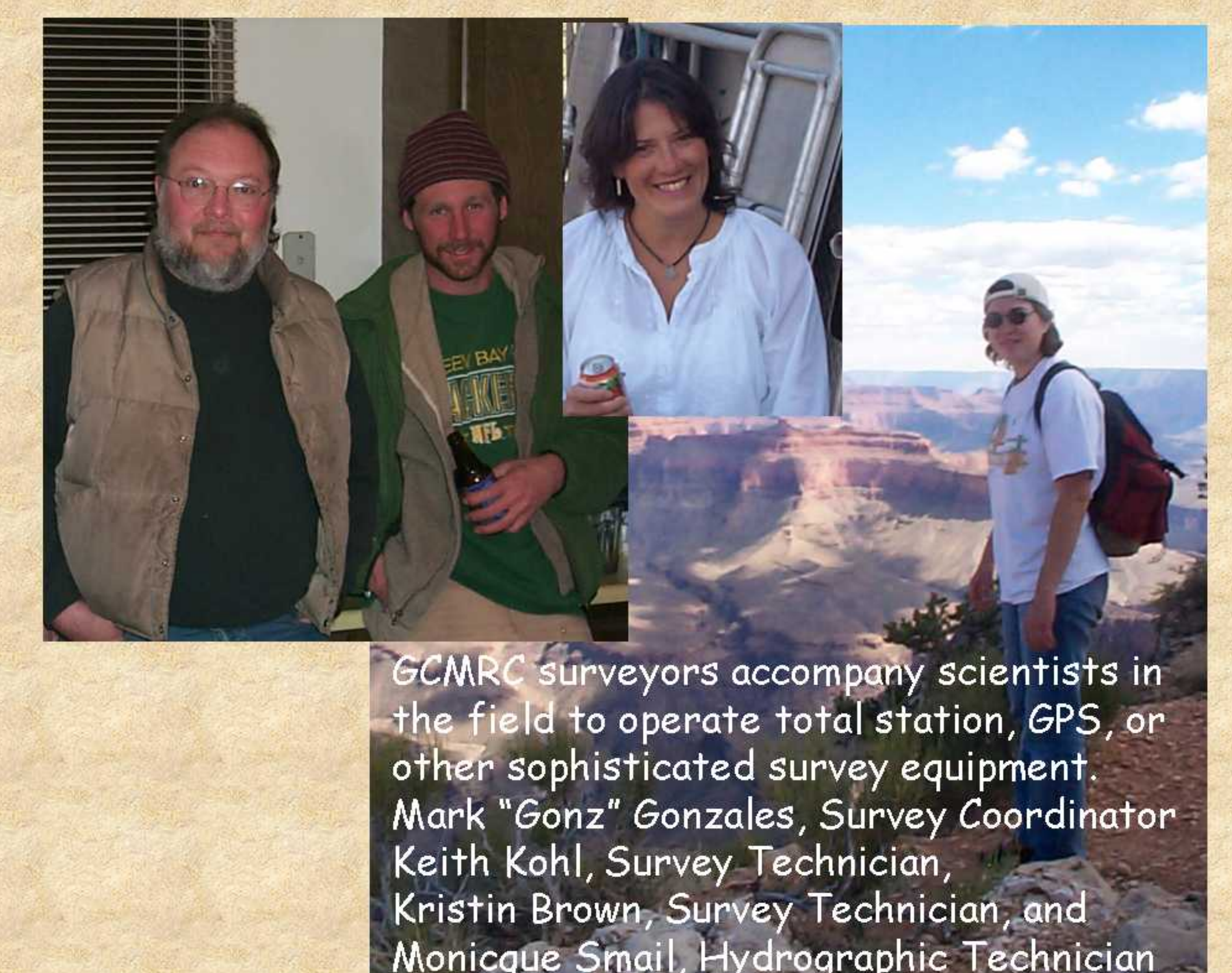


GPS derived ellipsoid heights are converted to real world elevations using geoid models.



Graphical and mathematical relationship between GPS Ellipsoid Heights, modeled Geoid Heights and real world Orthometric Heights.

## PEOPLE



GCMRC surveyors accompany scientists in the field to operate total station, GPS, or other sophisticated survey equipment. Mark "Gonz" Gonzales, Survey Coordinator, Keith Kohl, Survey Technician, Kristin Brown, Survey Technician, and Monique Smail, Hydrographic Technician.